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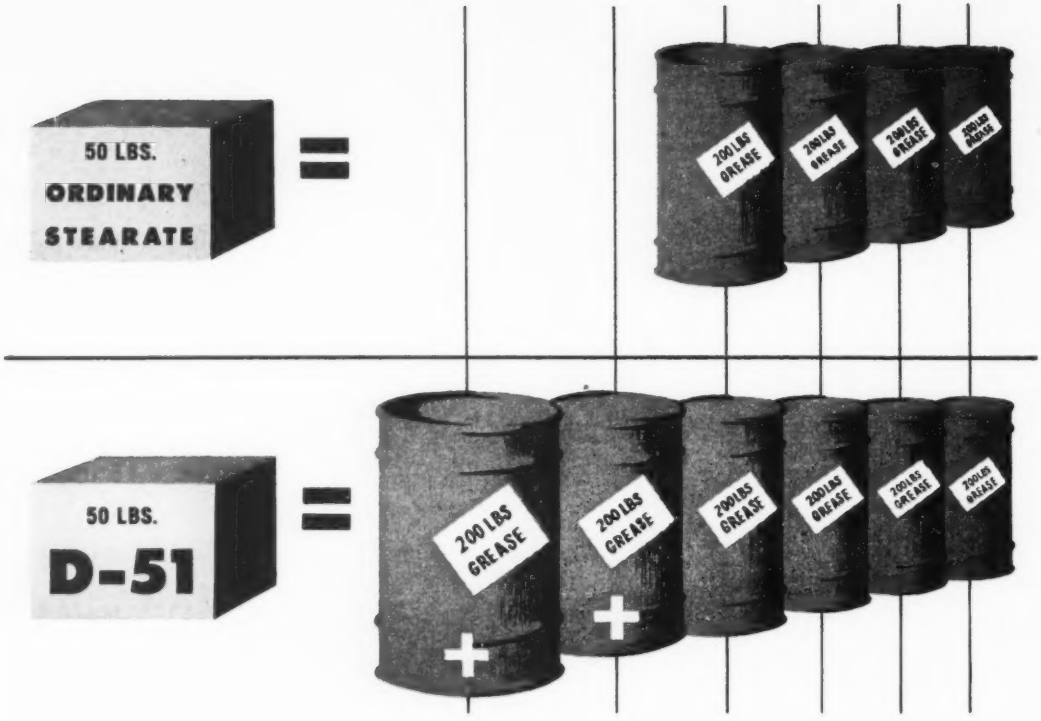

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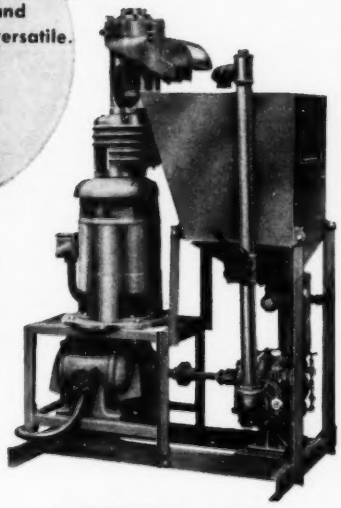

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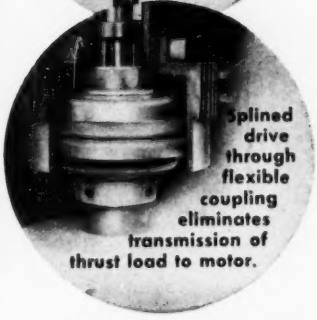

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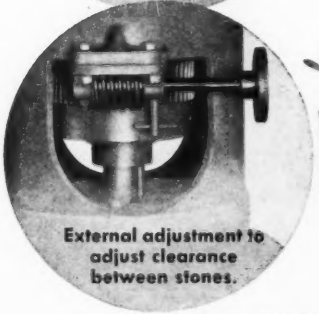

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Silicone Notes

ON LUBRICATION

REFERENCE NO. SL-51

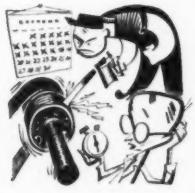
FILE SILICONE LUBRICANTS

Make sure you have basic data sheets BG-2, 5502, 7101. If misplaced write Department N-11

DOW CORNING CORPORATION
Midland, Michigan

DOW CORNING 44 GREASE

791 HOURS AT 400°F. plus 2033 hours of operation at 300°F. were ticked off before we reached an end point in testing bearings lubricated with Dow Corning 44 Silicone Grease. We used heat-treated, steel retainer bearings operating at 1750 rpm under a spring load of 150 pounds. After 250 eight-hour days at 300°F., we pushed the temperature up to 400. 791 hours later the bearing failed. That's at least 10 times the maximum life recorded for any organic grease tested at 400°F.



AFTER 754 HOURS at 390, 365 and 330°F. respectively, the life testing of Dow Corning 44 Grease in 3 similar bearings operating at the same speed under the same load was discontinued. Only the 390° bearing showed sign of failure. Under the same conditions, other bearings were operated at 385°F. for 814 hours and at 390°F. for 774 hours. The bearings were just beginning to be noisy.

RESULTS OF OUR LIFE TESTING at 350-400°F. have been confirmed by independent investigators. We feel justified, therefore, in raising the maximum operating temperature suggested for Dow Corning 44 Silicone Grease from 350 to 400°F. Maximum speed factor (mm. bore x rpm) remains at 150,000-225,000.

ANNEALING OVENS AT 1400°F. are located only 2 feet from bearings on motor directly coupled to forced draft fans. In spite of frequent relubrication with organic greases these bearings had a service life of about 6 months. The electrical foreman finally installed bearings prelubricated with Dow Corning 44 Grease. These bearings have never been relubricated and they are still in service after about 2 years of operation.

DOW CORNING SILICONE OILS

METAL COMBINATIONS now commonly used in bearings were developed to give maximum service with conventional lubricants. They are the result of years of Edisonian research. Yet many people assume that the lubricant is incidental; expect a synthetic lubricant to perform equally well between metals carefully selected for use with petroleum oils of radically different chemical structure. That's a fallacy that may lead to trouble in the use of synthetic lubricants, including our silicone oils and greases.

RELATIVELY CONSTANT VISCOSITY over a wide temperature span, exceptional heat stability and oxidation resistance are properties peculiar to our silicone fluids. And those are among the properties required of an ideal lubricant. The ability to reduce wear and friction is the other basic property and that depends in large measure on the metal combinations. Here's some data on the relative effectiveness of various silicone fluids as lubricants for various metal combinations.

METAL COMBINATION	*Dow Corning 200*	*Dow Corning 550*	*Dow Corning 710*
Cast iron—bronze	Good	Good	Good
Cast iron—steel	Poor	Poor	Poor
Bronze—nylon	Good	Good	Good
Steel—aluminum	Poor	Poor	Poor
Steel—babbitt	Good	Poor	Poor
Steel—bronze	Good	Good	Poor
Steel—cadmium	Good	Good	Good
Steel—chrome	VARIABLE RESULTS		
Steel—nylon	Good	Good	Good
Steel—steel	Poor	Poor	Poor
Steel—zinc	Good	Good	Good

These data were obtained with a Falex lubricant test machine under boundary or extreme pressure conditions. They are presented here only as a guide in selecting metal combinations to give maximum life with various Dow Corning Silicone Fluids. Careful breaking-in of bearing surfaces may be required.

TWO YEARS vs. 36 HOURS. That's the relative life of a few drops of Dow Corning 710 Fluid compared with any other lubricant tested in a clock motor fully exposed to the atmosphere.

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ABOUT THE COVER

At their nineteenth annual meeting N.L.G.I. Board Of Directors unanimously chose Fiske Brothers' Vice President, George E. Merkle, as the nineteenth President to serve their organization during the 1952-53 term of office. Active in the organization for many years, he was Vice President and Chairman of the Program Committee during the past year. His experience and knowledge of N.L.G.I. amply fits him for Presidency.

A Chemical Engineer major, he joined the chemical staff of Rhode Island State College following his graduation from Massachusetts University. While at Rhode Is'and State College he did post graduate work for his Master's and Doctor's degrees. After leaving the College he became Chief Chemist of Lister Chemical Works and later served in the same capacity for National Carbon Company.

It was in 1921 that he joined Fiske Brothers Refining Company as Chief Chemist, giving considerable attention to technical and production work. He is now their Vice President and General Manager.

He is co-author of two books written in association with Mr. Carlton Ellis: "Ultra Violet Rays and Their Applications", and "Synthetic Resins and Plastics".

In addition to his active interest and support of N.L.G.I., he is also a member of: American Chemical Society, American Institute of Chemists, American Society of Lubrication Engineers, American Petroleum Institute, American Society for Testing Materials, and American Society for Advancement of Science.

President's page

by George E. Merkle, President, N.L.G.I.

"I AM CONFIDENT OF CONTINUED PROGRESS"

The National Lubricating Grease Institute, now 19 years old, has enjoyed a steady and healthy growth and its membership includes nearly all of the prominent lubricating grease manufacturers in this country. It has also attracted attention in foreign countries because of the very good job it is doing particularly through its publication "The Institute Spokesman".

For the coming year the Directors of the Institute have conferred upon me the great honor of electing me your President. In this post I shall do all in my power to fulfill the duties of the office and justify the confidence they have placed in me.

Having just completed a year on our Program Committee I have had a chance to know better the cooperation one can expect from the Directors. I know that I can count on the help and cooperation of our members which has meant so much to my predecessors.

The troubled and uncertain times we face will impose many problems on all branches of the petroleum industry and in no small measure upon lubricating grease manufacturers. In addition to the ever increasing industrial requirements we are being called upon to supply many new and very special lubricants for the various Governmental branches.

As in the past there is little doubt that our industry will rise to the occasion and do the seemingly impossible even with material, equipment, and manpower shortages.

I am confident of continued progress in our most vital industry.

The Chemistry of Fats

A CHARACTERISTIC feature of fats is their complexity. No longer can we conceive of a fat as consisting of glycerol and three fatty acids for they are complex mixtures of mixed triglycerides of which the constituent fatty acids are both saturated and unsaturated. Indeed, the realization of the large number of possible combinations of glycerides in a fat serves to emphasize their complexity. Inherent problems of the molecular structure of the component glycerides of a fat have been a worthy and exciting challenge to the chemist, and although considerable progress has been made on the study of their composition through the application of such techniques as fractional distillation, fractional crystallization, selective hydrogenation, and chromatographic adsorption, developments during the past decade have indicated a quickened pace in the fundamental chemical study of these naturally occurring products.

In this brief discussion of the chemistry of fats attention in most respects must be centered on the chemistry of the fatty acids rather than on the glycerides. Many of the properties of the glycerides are a reflection of the properties of the fatty acids. Naturally occurring fats, in addition to containing predominantly triglycerides as the major constituents, contain phosphatides (triglycerides in which one of the three fatty acid groups may be considered as having been replaced with a phosphoryl choline group, lecithin, or a phosphoryl β-amino ethyl alcohol group, cephalin). Other minor constituents include sterols, pigments (carotene), antioxidants (tocopherols), and carbohydrate fragments. The latter are present in a few per cent or less and together with the phosphatides are removed to a greater or lesser degree in the refining process.

The complexity of the glyceride composition of a fat increases with the number of component fatty acids as it is well known that different fatty acid radicals combine with a single glycerol molecule.

Phosphatides. The phosphatides which are largely removed in the refining process of fats and oils occur to varying amounts in animals and vegetable fats, the latter containing by far the greater amount of phosphatide. The phosphatide content of animal fat is usually very low. The phosphatide in both animal and vegetable fat is usually associated and may be chemically combined with carbohydrate. The fatty acid composition, at least in vegetable phosphatides, approximates the composition of the oil in which they are found.

The two general classes of phosphatides occurring in vegetable fats are the lecithins and the cephalins, structures of which are indicated in Figure 1. The nitrogen-phosphorus ratio in both classes is usually 1:1.

Sterols. Sterols occur in both plant and animal fats. Those occurring in plants are called phytosterols and those in animals zoosterols. They comprise most of the unsaponifiable matter in a fat, the remainder consisting essentially of hydrocarbons (squalene, etc.).

The most extensively investigated animal sterol is cholesterol. The plant sterols occur in considerable numbers in nature; two of them, β-sitosterol and stigmasterol, are fairly well characterized.

Fatty Acids. The naturally occurring fatty acids, in the main, are divided into two general classes, the saturated and unsaturated. The saturated acids, characterized by the formula $C_nH_{2n+1}COOH$, are normal, monobasic, aliphatic acids and, with but one exception (iso-valeric) contain an even number of carbon atoms. The unsaturated acids for the most part consist of 18 carbon atoms with one or more double bonds in the aliphatic chain. Both the saturated and unsaturated acids are structurally related.

The saturated fatty acids include lauric, myristic, palmitic, and stearic as the more important naturally occurring fatty acids. The more important unsaturated acids are oleic, linoleic, and linolenic acids. These groups of acids with but few exceptions occur to the greatest extent in most natural fats and oils. Tables I and II include, in addition to these acids, other saturated and unsaturated acids.

Isomeric Fatty Acids. Although it is not normal for saturated fatty acids to exhibit isomerism, unsaturated fatty acids show both positional (difference in position of double bonds) and geometric (*cis-trans* isomerism). Isomers of oleic acid

by B. F. DAUBERT

Department of Chemistry

University of Pittsburgh

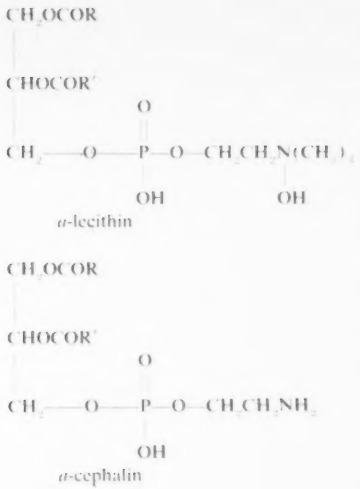


FIG. 1. Types of phosphatides.

(9,10-octadecenoic acid) which are known to be naturally occurring include petroselinic acid (6,7-octadecenoic acid) and vaccenic acid (11,12-octadecenoic acid). Eladic acid, the *trans* isomer of oleic, does not occur in natural fats and oils, at least so far as I am aware. Several isomers of normal linoleic acid (9,12-octadecadienoic acid) have been reported to occur naturally, and it is well known that isomers of linolenic acid (9,12,15-octadecatrienoic acid) occur in natural fats.

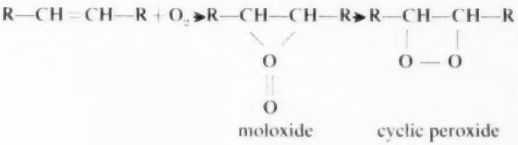
However, although few isomeric fatty acids occur in nature, it is quite possible that a variety may be produced in processed fats and oils by (1) hydrogenation of monoethenoid, conjugated an[illegible] non-conjugated polyethenoid fatty acids, (2) action of isomerization and heat, (3) debromination of tetrabromostearic acids, (4) catalytic dehydration of naturally occurring hydroxy fatty acids. Positional and geometric isomers may also be prepared artificially or synthetically.

The partial hydrogenation of unsaturated fatty acids or glycerides containing them usually results in a variety of isomeric acids. The amount and kind depend upon the nature of the original oil and the conditions of hydrogenation.

The two methods which are customarily used to determine the position of the double bond in the aliphatic chain are oxidation and ultraviolet absorption. Both methods however are somewhat limited. Neither method is satisfactory for distinguishing geometric isomers (*cis-trans*). More extensive use however of infrared analysis has served to provide an adequate method for distinguishing *cis* from *trans* isomers. Fatty acids of *trans* configuration exhibit characteristic infrared absorption in the region of 10.3 μ.

Autoxidation. The spontaneous addition of atmospheric oxygen to the double bond system of the unsaturated fatty acids in a glyceride to form peroxides which later result in the formation of short chain products and thus rancidity in edible fats is differentiated from the purposeful addition of oxygen to highly unsaturated fatty acids to cause polymerization into useful products.

Since autoxidation is the major cause of rancidity, it is perhaps appropriate to discuss briefly some of the postulated mechanisms of this. The classical concepts of the reactions that occur during oxidative rancidity involve the initial addition of oxygen to an unsaturated carbon-to-carbon linkage and the subsequent formation of a cyclic peroxide. Staudinger believed that a highly reactive moloxide stage precedes the formation of the cyclic peroxide:



The active peroxide once formed presumably undergoes rapid decomposition with the simultaneous formation of new peroxide molecules. Several mechanisms have been postulated for the decomposition of these organic peroxides and initiation of a chain of reactions accompanying the development of oxidative rancidity. One involves a suggestion that the peroxide reacts with a saturated fatty acid chain by a process of dehydrogenation with the corresponding formation of a new double bond, which then peroxidizes and subsequently decomposes into short-chain saturated aldehydes and acids.

Perhaps a more complete understanding of the autoxidation process has resulted from the work of Farmer, who postulated a hydroperoxide as the first compound formed in the autoxidation of olefinic type substrates (e.g., unsaturated fatty acids). If the hydroperoxide theory is correct, then a reinterpretation of the autoxidative process must be made in the light of this theory. The hydroperoxide is formed presumably by a free radical mechanism of olefinic peroxidation. Secondary reactions subsequently lead to the production of scission products.

TABLE I

Saturated Fatty Acids

Name	Number of carbon atoms	Source with highest content Source	%	Other sources
Caproic	6	Coconut	2	Butter, palm nut oils, etc.
Caprylic	8	Coconut	10	Butter, palm nut oils, etc.
Capric	10	Elm	50	Coconut, butter, palm nut oils, etc.
Lauric	12	Cawal-Kurundu	86	Laurel oil, spermaceti, babassu, palm kernel, etc.
Myristic	14	Nutmeg butter	77	Kombo, dika, ucuhuba
Palmitic	16	Japan wax	77	Animal and vegetable fats
Stearic	18	Bouandja (allan-blackia)	57-63	Animal and vegetable fats
Arachidic	20	Rambutan tallow	35	Peanut oil
		Niam	14.2	
Behenic	22	Xylia xylocorpa	17.3	Peanut oil, oil of Ben
Lignoceric	24	Coral tree	26	Peanut oil, rapeseed oil, cerebrosides
Carnaubic	24	.....	.....	Carnauba wax
Cerotic	26	.....	.....	Beeswax, wool fat, opium wax
Melissic	30	.....	.....	.....

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IMPORTANT CHEMICAL CHARACTERISTICS OF FATS

Saponification Value. Considerable information concerning the nature of a fat or oil can be gained from a knowledge of the saponification value. The saponification values of neutral glycerides and other esters of fatty acids vary with the nature of the fatty acids. Oils of high saponification number contain fatty acids of low molecular weight while the converse is true for oils containing high molecular acids. The use of the term saponification equivalent is preferred by many as an indication of the molecular weight of a single fatty acid or the average molecular weight of a mixture of fatty acids; the saponification equivalent in the case of glycerides is one-third of their molecular weight. If the saponification number is known, however, the saponification equivalent can be calculated as follows:

$$S.E. = 56{,}104 \div Sap.No.$$

The S.E. to be of experimental value in determining molecular weights must be determined with care and precision.

Iodine Value. The simplest and most rapidly determined chemical constant for a fat or oil is its iodine value. It is a most valuable characteristic in fat analysis for it measures total unsaturation. It is highly accurate and gives near theoretical values except in cases of conjugated double bonds or triple bonds, or when double bond is near a carboxyl group. The iodine value will, as a general rule, lead in the most rapid manner to the identification of a fat or oil. One can certainly determine the class to which a given oil or fat belongs if the iodine value is known. Despite its usefulness however the absorption of hydrogen (hydrogen number) is perhaps the best indication. of total unsaturation. The possibility of halogen substitution is always present in iodine value determinations and may lead to faulty results. The mechanical difficulties involved in the determination of hydrogen absorption however militates against its wide use.

Valuable indications of the nature of a fat or oil can be obtained from the Reichert-Meissl number for it is generally known that most naturally occurring fats and oils contain but small quantities of soluble volatile acids. It therefore follows that a relatively high Reichert-Meissl number would be a characteristic and possibly lead to information concerning the nature of the fat.

Methods available for identification and amount of specific fatty acids in a fat include thiocyanogen number (linoleic and linolenic acids), tetrabromide number (linoleic acid), hexabromide number (linolenic acid), diene number (conjugated acids). These methods, for various reasons, have largely been supplanted by the spectrophotometric procedure although it is claimed by many that the thiocyanogen determination, if carefully controlled, gives a more accurate indication of linoleic and linolenic acids, despite its empirical relationship, than the spectrophotometric procedure.

Acetyl value of a fat or oil is a valuable characteristic only if triglycerides containing hydroxy fatty acids are present, e.g., castor oil. The acid value, although a variable constant, is important because the extent of hydrolysis (deterioration) or oxidation can be followed by its determination. Therefore it is particularly useful in determining the quality or freshness of fats and oils.

Reprinted from "The Journal of the American Oil Chemists' Society", October, 1949.

TABLE II

Unsaturated Fatty Acids

Name	Carbon number	Double bonds	Source with highest content Source	%	Other Sources
Crotonic	4	1	.....	.....	Croton oil
Tiglic	5	1	.....	.....	Croton oil
Oleic	18	1 (9)	Coula	95	Animal and Vegetable fats
Elaidic	18	1 (9)	.....	.....	Hydrogenated fat? Does not occur in natural fat
Petroselinic	18	1 (6)	Parsley	76	Umbelliferae oils
Erucic	22	1 (13)	Nasturtium	82	Cruciferae oils
Linoleic	18	2 (9, 12)	Safflower	78	Linseed and cottonseed oils
Tariric	18		Tariri (Picramnia Sow)	95	.....
Linolenic	18	3 (9, 12, 15)	Perilla oil	70	Linseed oil
Elaeostearic	18	3 (9, 11, 13)	Tung oil	75-95	.....
Clupanodonic	18	4	.....	.....	Japanese sardine oil
Arachidonic	20	4	.....	.....	Animal fat, phosphatides

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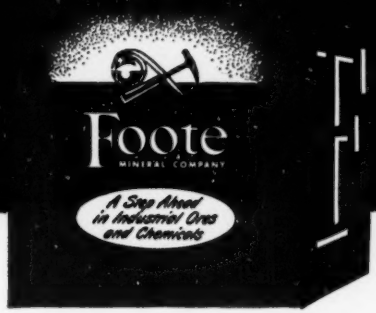

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Petroleum Sulfonates in Grease Manufacture

—A Review of the Patent Literature

by R. K. RHODES
Department of Industrial Research
L. Sonneborn Sons, Inc.

Current textbooks and literature references on the subject of grease manufacture reveal little information on the use of petroleum sulfonates in grease manufacture.

There are, however, sufficient references in the recent patent literature to indicate that petroleum sulfonates—either as the alkali, alkaline earth, or heavy metal salts—are capable of imparting new and valuable properties to consistent lubricating greases. One of these patents covers a lubricating grease (1) employing an alkali petroleum sulfonate which acts as a stabilizer, preventing the separation of the oil from the soap. Others (2, 11, 12, 22) describe greases utilizing oil soluble petroleum sulfonic acid soaps, which have higher dropping points, flatter temperature—consistency curves and lower differentials between unworked and worked penetration than do those greases that do not contain petroleum sulfonates.

Three other patents (3, 4 and 21) describe greases or wire rope compounds that contain alkali or alkaline earth petroleum sulfonates to impart rust preventive properties to these grease lubricants. (4) also indicates that the addition of petroleum sulfonates to the grease prevents bleeding of the oil from the grease.

Other inventions (5, 6, 7, 16, 19 and 20) claim a lubricant composition consisting of mineral oil and a complex reaction product of sodium, calcium or strontium petroleum sulfonates and calcium acetate, calcium nitrate or calcium ethane sulfonic acids, the petroleum sulfonate being used in place of soap to impart a grease consistency to the mineral oil. In addition, (20) also claims grease of better mechanical stability and sheer resistance. Similarly, (23, 24, 25, 26 and 27) suggest the use of alkaline earth petroleum sulfonates in place of soap.

Two other patents (8 and 9) describe the use of strontium and calcium petroleum sulfonates of high molecular weight to impart extreme pressure properties to lubricating greases.

Patents (10, 11 and 22) indicate that petroleum sulfonates, preferably as the sodium salt, solubilize and plasticize fatty acid soaps. These same patents also claim that greases containing petroleum sulfonates possess anti-oxidation properties. In this connection, petroleum sulfonates not only act as a solubilizer for grease ingredients but also impart hot water resistance to high temperature greases (13).

Various patents were published that claim improved grease structure for greases formulated with oil soluble petroleum sulfonates. Thus (14) describes a grease containing lead sulfonate which imparts softness and workability to high temperature greases. Similarly, (17 and 18) state that oil soluble petroleum sulfonates improve the texture and maintain a softness and an unctuous property to greases as well as improving the mechanical stability of greases with sodium petroleum sulfonates (18). Reference (12) states that preferably calcium petroleum sulfonates are important in preparing "reversible" lime soap grease—greases that can be melted and resolidified without losing their grease structure. Another patent (15) describes the use of sodium petroleum sulfonates as a wetting agent for grease composition containing petroleum and wax, so that uniform, smooth, non-lumpy, non-bleeding greases result.

From the above, the functions of petroleum sulfonates in grease making may be summarized as follows:

1. Minimize bleeding or sweating of the oil from the finished grease.
2. Impart grease-like structure to mineral oils.
3. Stabilize and improve the structure of the finished grease.
4. Improve the anti-rust and anti-oxidation properties of the finished grease.
5. Control plasticity imparted by fatty acid soaps.
6. Increase viscosity of the finished grease.
7. Solubilizer for grease ingredients.
8. Impart extreme pressure properties to grease.
9. Improve consistency — temperature characteristics of finished grease.
10. Wetting agent for certain grease stocks.

PROPERTIES OF PETROLEUM SULFONATES

UNIFORM COMPOSITION

While in the past, petroleum sulfonates were obtainable only as a crude, non-uniform by-product of white oil refining, they have, in response to an increasing industrial demand, been made available in a highly purified, more concentrated and strictly standardized forms.

In marked contrast to unrefined petroleum sulfonates, which contain excessive amounts of water, alkali, salts and other impurities, a highly refined, uniform product is practically free of unwanted impurities of any kind and is carefully adjusted to possess neither free alkalinity nor free acidity. Such a highly refined sulfonate is required for grease manufacture, since salt impurities, inorganic acidity or alkalinity

would upset the homogeneity of the two-phase grease system, resulting in unstable, inefficient greases.

SOLUBILITY

Petroleum sulfonates which are primarily oil soluble will, in proper concentrations, disperse in hot water. They form first an opalescent solution which becomes milky upon the addition of large amounts of sulfonate. Then, when the amount of sulfonate is further increased to approximately 12%, the solution becomes clear again. Eventually, if still more sulfonate is added to the hot water, a thick but clear gel is formed. It is the formation of this gel, the ability of petroleum sulfonates to absorb and hold an optimum amount of water, that demonstrates the usefulness of these products in grease manufacture to function in place of soap and to stabilize and impart rust preventive properties to the grease.

Petroleum sulfonates readily solubilize fatty acid soaps and are thus fully compatible with the usual metallic soaps used in the preparation of greases.

STABILITY

Petroleum sulfonates are stable up to nearly 400° F. They are thus able to maintain the grease structure even at elevated temperatures, minimizing syneresis, particularly at lubricating temperatures, minimizing systems, petroleum sulfonates are highly resistant to hydrolysis. Hence, grease that come in contact with water and contain petroleum sulfonates, have no tendency to develop acidity and are, therefore, homogenous and non-corrosive and function with utmost efficiency even under adverse operating conditions.

TYPICAL COMPOSITION OF A PETROLEUM SULFONATE

A sodium petroleum sulfonate found useful in grease manufacture has the following typical analysis and properties:

	% by Weight
Sulfonates	62.0
Mineral Oil	33.0
Water	5.0
	100.0
Molecular Weight	400/470
Free Acidity or Alkalinity	None
Inorganic Salts	None
Specific Gravity @ 60°F.	1.02
Furol Viscosity @ 210°F.	150
Flash Point °F. (open cup)	400
Fire Point °F. (open cup)	450

SUMMARY

Greases containing petroleum sulfonates either as the sodium, alkaline earth or heavy metal salts are non-separating, highly stable products with positive rust inhibiting properties. According to the patent literature, greases containing petroleum sulfonates either as the sodium, alkaline earth or heavy metal salts, have an improved grease structure producing highly stable products with rust inhibiting and anti-oxidizing properties. The same petroleum sulfonates increase the viscosity of the finished grease and also improve the consistency temperature characteristics of the grease. They do in fact impart a grease-like structure to mineral oils and act as solubilizers and wetting agent as well as plasticizer for various grease ingredients.

Petroleum sulfonates are, therefore, assuming a role of increasing importance in the manufacture of greases which meet the mounting complexities of new engineering and which afford greater protection and longer life to mechanical parts thus insuring increased operating efficiency and economy.

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17. U.S. Patent 2,265,791—John C. Zimmer and Arnold J. Morway (assigned to Standard Oil Development Co.)
18. U.S. Patent 2,468, 098—Arnold J. Morway and Cloyce R. Daniels (assigned to Standard Oil Development Co.)
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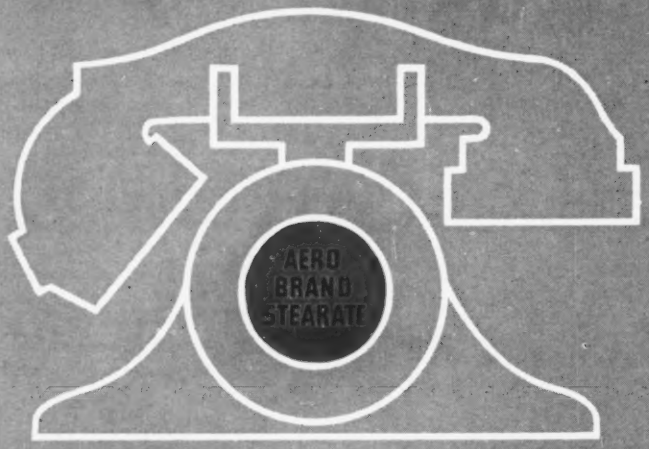
26. U.S. Patent 2,417,432—
27. U.S. Patent 2,417,433—

for greater effectiveness in grease formulation



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Patents and Developments

HIGH TEMPERATURE GREASES

Soda soap greases are becoming more and more available for lubricating anti-friction bearings operating at fairly high temperatures and, as a result, the industries are increasing their operating temperatures. In U. S. patent 2,468,099 the melting points of such greases are claimed to be raised by incorporation of 0.1-5% of an acidogenic material such as acrylic acid, methacrylic acid, crotonic acid, etc. Similar use of glycolic or hydroxyacetic acid, beta hydroxy butyric acid, aceto-acetic acid, etc. is also covered in U. S. patent 2,468,098.

However, difficulties appear to have been encountered, particularly with acrylic acid which is a highly toxic material as well as an expensive one. In U. S. patent 2,565,981, Standard Oil Development Co. finds that acrylic esters, which are relatively harmless to the skin, may be used in lieu of the acids in the preparation of the superior greases. In fact, other esters of low molecular weight monobasic acids, such as crotonic, benzoic, glycolic, hydroxy butyric, etc. may be used advantageously, as well as heterocyclic esters such as the aliphatic furoates.

These esters are added in the proportion of 0.1-5% by weight of acid component to the mineral oil and fatty material prior to saponification. Saponifying agent, such as sodium hydroxide, is added and the grease is cooked in the conventional manner to a temperature which may be as high as 500°F or more, but preferably 250°-450°F.

Since the ester is hydrolyzed in the process, it is preferable to use a polymerization inhibitor (0.1-2%) when a polymerizable acid is liberated. Such an inhibitor may be hydroquinone, thymol, phenyl naphthylamine, polyalkylated phenols, or aromatic amines. At the same time an antioxidant such as phenyl naphthylamine also may be added.

One such grease had the following composition:

	Percent
Hydrogenated fish oil acids (Hydrofol acids 54)	14.00
NaOH	4.25
Methyl ester of acrylic acid	3.96
Mineral lubricating oil of 500 S.S.U. viscosity at 100°F	76.75
Phenyl alpha naphthylamine	1.00
Hydroquinone	0.04

This grease showed the following inspection:

Percent free alkalinity as NaOH		0.53
Dropping point	°F	440
Worked penetration:		
(60 strokes)	mm./10	250
(6000 strokes)		280
(75000 strokes)		327
Water resistance (AN-G-15 method)—°F		125
Water temperature, percent loss, none		

Various other additives which may be used include extreme pressure compounds, tackiness or stringiness agents, metal deactifiers, corrosion inhibitors, etc. Mineral oil should be used, although a synthetic ester type lubricant may be prepared by using only enough mineral oil to cook the soap-forming ingredients properly, after which an ester oil such as di- 2 ethyl hexyl sebacate may be used in lieu of the remainder of the oil.

STABLE ALKALI-METAL GREASES

Among the deteriorating influences working on greases in service are oxidation, bleeding (due to the fact that the soaps have a tendency to synergize), age-hardening (apparently caused by formation of cross layers in soap fibers), and lack of resistance to shear. Bleeding often is counteracted by the time-consuming control of cooling, extensive working in special homogenizers, reduction of soap content to below 5% (which limits the grease uses), or increasing soap content to a maximum, thereby making the grease too costly and of generally undesired consistency.

In its U. S. patent 2,566,793, Shell Development Co. describes a grease which avoids the above objections by using a mixture of two different alkali metal soaps, i.e. one of the soaps must be a lithium soap of hydroxy fatty acids and/or their glycerides, while the other soap can be a non-lithium alkali metal soap of fatty acids or their glycerides (such as sodium or potassium soaps). Also, the ratio of the two soaps is critical and should be within the weight ratio limits of lithium soap to the non-lithium alkali metal soap of from 90:10 to 95:5. Furthermore, the hydroxy content of the soap mixture should be between the limits of 3.2 and 4.0% by weight (preferably 3.3-3.0%).

Among the hydroxy fatty acids applicable for such use are dimethyl hydroxy caprylic, dimethyl hydroxy capric, hydroxy physetoleic, ricinoleic, ricinelaidic, 12-hydroxy stearic, 9, 10 dihydroxy stearic, 4 hydroxy palmitic, linusic, sativic, lanoceric, dihrydroxy gadoleic, dihydroxy benhenic, quince oil, and other acids, preferably having 14-32 carbon atoms and having the hydroxy group at least 12 carbon atoms removed from the carboxyl group.

The mineral oil base may be substituted in part or wholly by polymerized olefins, copolymers of alkylene glycol and alkylene oxides, organic esters, such as 2-ethyl hexyl sebacate, dioctyl phthalate, trioctyl phosphate, polymeric tetrahydrofuran, polyalkyl silicon polymers, etc.

Among the materials which may be incorporated in the grease may be oxidation inhibitors such as N-butyl p-phenylene diamine, naphthylamines, dinaphthylamines, tetramethyle diamino diphenyl methane, phenylene diamine, petroleum alkyl phenols, and 2.4 ditert. butyl 6 methyl phenol.

Corrosion inhibitors which may be added include N-primary amines containing at least 6 and more than 18 carbon atoms, alkyl substituted oxazolines and their fatty acid salts.

Extreme pressure agents also may be added, including phosphorus acid esters, neutral aromatic sulfur compounds such as diaryl sulfides and polysulfides, selenides and polyselenides, sulfurized fatty oils and monohydric alcohols in which the sulfur is tightly bound, sulfurized long chain ole-

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- Colgate-Emery Process for the continuous high-pressure splitting of fats.
- Discovery and plant scale utilization of the patented, high-temperature, continuous dimerization process for producing di-linoleic acid (Emery 955 Dimer Acid).
- Commercial application of the oxidation of oleic acid to produce two exclusive products, Azelaic and Pelargonic Acids.
- Production of the first solvent crystallized, low-titer vegetable fatty acids for alkyd resin manufacture.
- Introduction of Emersol 132 Lily Stearic Acid, the highest quality crystalline stearic acid available.
- Production of Emersol 233LL Elaine, the world's purest commercial oleic acid.

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fins, sulfurized, phosphorized fatty oils, acids, esters and ketones, chlorinated hydrocarbons, or chlorinated esters or acids.

Additional additives which may be added are anti-wear agents such as oil-soluble urea or thio-urea derivatives, VI improvers, oiliness agents, and pour point depressors. The amount of soap in the finished grease may be about 8% by weight.

EXTREME PRESSURE SOAPS

Soaps now available and capable of carrying extreme pressures in lubricants are not very numerous and are claimed to have certain disadvantages. For example, lead oleate has a low oil solubility and its load carrying capacity is not as high as is desired for some purposes. If lead naphthenate is used, it has a thinning-out effect which requires excessive soap thickener.

In its U.S. patent 2,567,023, Standard Oil Development Co. describes a method for producing polyvalent metal soaps by reacting an aliphatic mercaptan with acrylonitrile accompanied by hydrolysis with sodium hydroxide. For example, a C_{12} aliphatic mercaptan obtained from petroleum, when reacted with acrylonitrile in this manner, yielded a soap having the formula $C_{12}H_{25}SCH_2CH_2COONa$

By double decomposition, the zinc, manganese, copper, cobalt, calcium, barium, strontium and lead soaps may be produced. The lead soap of the aforesaid acid contains 24.6% lead and 8% sulfur. It is soluble in high viscosity index solvent extracted oils and is compatible with calcium base greases in at least 15% concentration by weight; and has an appreciably higher load carrying power over lead oleate.

COMMERCIAL DEVELOPMENTS

Gaunt Industries, 827 Irving Pk. Rd., Chicago 13, is selling a pen-size device (Hypo-Lub) for fine greasing applications of interest to watch makers, instrument firms, printers, etc. Pressing a plunger dispenses the required amount of grease out of a hypodermic needle (J. Commerce 8/28/51 p. 4).

A grease-grade lead naphthenate is being made by Witco Chemical Co. in 30% and 33% concentrations (Chem. & Engrg. News 9/3/51, p. 3654).

ISSUED PATENTS

British Pat. 648,763 (Shell Oil Co.) Manufacture of aluminium soap greases.

British Pat. 658,511 (Union Oil Co. of California) Lubricating greases.

U. S. Pat. 2,563,636 (Ballard) Hydraulic grease gun.

U. S. Pat. 2,563,716 (Stewart-Warner Corp.) Portable lubricant pressure pump.

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1950 was a record production year, with *over 8 million* cars and trucks built in the U. S. This year started out at an even higher rate, but defense production forced sharp cuts in manufacturers' quotas for the last half. Now it appears almost certain that continuing military demands of raw material will keep automobile output down for some time.

More Old Cars In Use

Even with recent high production, the proportion of older cars in use has been mounting at an alarming rate. In 1941, only 17% of all cars on the road were 10 years old or older. Compare this with a survey of this year, showing that 44% of the total are in the 10-year-old bracket. Obviously, with a shortage of new-car replacements, this figure will go even higher.

Unquestionably, the presence of more old cars on the road has contributed heavily to the nation's appalling traffic accident toll. Last year, traffic accidents killed 35,000 and injured, 1,200,000, according to National Safety Council figures. With a 6% increase in deaths reported for the first five months of 1951, the NSC forecasts a possible total of 37,800 for this year. High cost of repairs resulting from accidents and breakdowns is also evident in rapidly rising auto insurance rates.

Reprinted from "The Chek-Chart Service Bulletin" Vol. 22, No. 8.

Safety Checks Show Danger

Voluntary safety-checks of cars all over the country during May revealed that *one out of every three* needed maintenance attention to one or more parts affecting safe operation. Brakes, lights, windshield wipers, and exhaust systems were among the most frequent offenders.

James J. Newman, Chairman of the Inter-Industry Highway Safety Committee, pointed out that the overall condition might be even worse, since many volunteers were owners of post-war vehicles. He stated, "The fact that at least 30.6% of the cars checked by dealers were in need of maintenance attention to parts affecting safe operation points up the need to have cars 'Serviced for Safety' periodically."

Recognizing the seriousness of the situation, safety groups and other organizations are planning and carrying out intensified programs to promote safe driving and proper maintenance practices.

It is vital that the oil and automotive industries get behind their *own* safety program, to promote safety through their *own* sphere of influence — automotive lubrication. One of the most effective ways of accomplishing this is by renewed emphasis on the slogan, "Lubricate for Safety Every 1,000 Miles".

First Used in 1936

Over 15 years ago, CHEK-CHART was instrumental in developing and publicizing this slogan. Beginning with a National "Lubricate for Safety" Week in May of 1936, the slogan was brought into national prominence by trade papers, state associations, and other organiza-

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tions. The Lubrication Committee of the API adopted it as their official slogan.

Oil companies used it in their dealer and consumer advertising. Service Station attendants preached it to every motorist who drove into their stations. Constant repetition implanted this idea firmly into the minds of millions of car owners, until it became a regular part of car service.

Many of these groups have done, and are still doing, an excellent job of keeping the slogan alive in the minds of the motoring public. But some petroleum marketers who entered enthusiastically into the program have "tapered off" in their promotion of this vital message. New personnel is not always properly impressed with its importance. Recent record production of new cars, and much-publicized improvements in lubricants, have led some car-owners to extend the lubrication interval on their cars.

Needs Renewed Emphasis

Whatever the reason, it is fairly obvious that regular 1,000-mile lubrication does not now occupy the important position that it did in the minds of many motorists—yes, and even many automotive service men! To overcome this lackadaisical attitude, "Lubricate for Safety Every 1,000 Miles" needs renewed and even stronger emphasis throughout the oil and automotive industries.

Lubrication makes two important contributions to car safety. First, it reduces mechanical wear, prevents rust and corrosion, and permits smoother functioning of moving parts. A well-lubricated car is safer to drive because it reduces fatigue, allows faster, more positive reaction in emergencies.

Second, and no less important, frequent lubrication gives the service man the opportunity to check the condition of the car. Most of the faulty items revealed by the "Safety Checks" are regularly inspected as part of standard 1,000-mile lubrication procedures. Service Station men are trained to bring to the immediate attention of the car-owner any of these parts that need repair or replacement.

It is easy to see, therefore, the valuable contribution that oil companies can make to automobile safety by joining in a campaign to get *every car-owner* to "Lubricate for Safety Every 1,000 Miles".

No Extra Advertising Cost

The use of this slogan need not add to any company's advertising costs. Rather, the slogan is intended as a *supplement* to existing and future advertising campaigns, as the catchphrase "Say It With Flowers", for example, has been used so successfully by florists.

By following this idea, each oil company can fit the slogan into its own individual promotion, and still obtain the cumulative effect of repetition by the entire industry.

Following are some of the many ways that oil companies can feature the "Lubricate for Safety" slogan:

1. In newspaper and magazine ads.
2. On outdoor signs and billboards.
3. On "A" boards, posters, and other Service Station advertising.
4. In direct-mail advertising literature.
5. As part of radio and TV commercials.
6. In dealer promotion and training.
7. On all House Organs, Service Bulletins, and other company publications.
8. On letterheads, envelopes, and postage meter imprint.
9. In publicity releases to the press.

(*Continued on page* 28)

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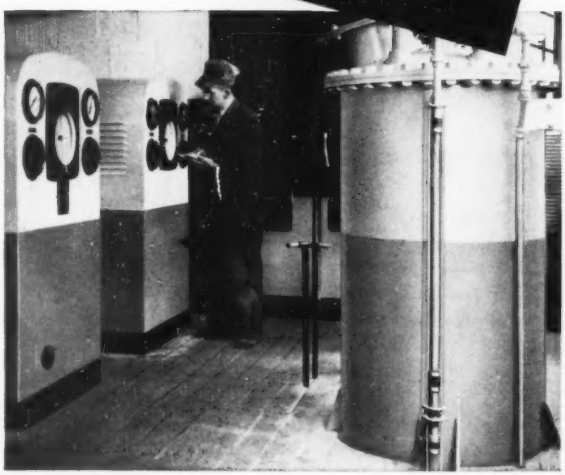
USERS OF VOTATOR Grease-making Apparatus report substantial reductions in the quantity of stearate required to make aluminum stearate lubricating grease, compared to batch methods. That's because the more thorough mixing action gives a greater dispersion of stearate through the oil.

VOTATOR Grease-making Apparatus processes continuously—always under precise, automatic control. Thus wastage encountered with batch mixing can be eliminated. Moisture content and temperature can be controlled accurately—your grease always processed as you specify.

VOTATOR Grease-making Apparatus can be applied for processing of many types of greases. Write now for case history facts. The Girdler Corporation, Votator Division, Louisville 1, Kentucky.



GIRDLER CORPORATION
Votator Division

VOTATOR—T. M. Reg. U. S. Pat. Off.

PEOPLE in Your Industry

APPOINTED ASSISTANT TO SALES MANAGER

John E. Farbak, sales representative for the Swift & Company Technical Products plant at Hammond, Indiana, has been appointed assistant to the sales manager, according to F. E. Lacey, manager. He will assist F. H. Beneker, in charge of sales.

Mr. Farbak joined Swift as a chemist in the Research Laboratories January 14, 1946. He became an industrial oils sales representative in October, 1948, and about a year later was transferred to the Hammand Technical Products plant.

Appointment of Mr. Farbak as an assistant to the sales manager is intended to provide closer contact with sales people in the various territories, Mr. Lacey said.

R. S. WEISZ WINS TOP FOOTE LITHIUM AWARD

Robert S. Weisz, 33, Research Engineer at the R.C.A. Laboratories at Princeton, N. J., has been granted the Grand Award in Foote Mineral Company's Lithium Award Program. Titling his paper "Ferromagnetic Spinels Containing Lithium", the author demonstrated an unusually wide and penetrating background in the field of Inorganic Chemistry.

A winner of the Sage Fellowship in Chemistry (1941), and later a Westinghouse Research Fellow, Weisz took his Ph.D. in Organic Chemistry at Cornell University in 1942. On leaving Cornell he was associated with the Westinghouse Research Laboratories in East Pittsburgh until 1946 when he joined Thomas A. Edison, West Orange, N. J., and subsequently moved to his present position with R.C.A. in 1949.

PURPOSE AND BACKGROUND OF THE FOOTE LITHIUM AWARD PROGRAM

In sponsoring the $1,000 Lithium Award Program, Foote Mineral Company seeks to stimulate research in the technology of lithium in ceramics. In recent years, research has brought about major changes in ceramic products. These new developments have resulted in lower maturing or melting points, economic advantages in longer refractory life, faster firing schedules and many other significant improvements.

NOPCO ANNOUNCES TRANSFER OF JOHN R. CRAIG TO TECHNICAL SALES FORCE

Effective October 1, John R. Craig becomes a member of the Mid-West sales force for Nopco Chemical Company, it

Laboratory improved

Automotive Lubricants • Greases and Cutting Oils

PENOLA OIL COMPANY
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GULF

A Complete Line of Quality Oils and Greases

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Atlanta—New Orleans—Houston
Toledo

REFINERIES
New York, N. Y.—Philadelphia, Pa.
Pittsburgh, Pa.—Toledo, O.—Cincinnati, O.
Port Arthur, Tex.—Fort Worth, Tex.
Sweetwater, Tex.

Monsanto SANTOLENE C stops corrosion

It's easy to prevent corrosion in tanks and drums used to store or transport gasoline, kerosene, fuel oil and other light petroleum products. Just add a minute quantity of Santolene C, Monsanto's rust inhibitor. For details on the use of Santolene C, write MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1700 South Second St., St. Louis 4, Missouri.

TESTS PROVE that Santolene C stops corrosion. Results of tests, at various concentrations of the additive in fuel oil, are illustrated. (A) No Santolene C. (B) 10 ppm Santolene C. (C) 20 ppm Santolene C. Similar results have been obtained by tests in other light petroleum products.

MONSANTO
CHEMICALS—PLASTICS

SERVING INDUSTRY... WHICH SERVES MANKIND

was announced recently from the company's home offices at Harrison, New Jersey. His territory will include the states of Texas and Oklahoma.

Mr. Craig has been a member of the Nopco organization since 1941. He has worked extensively in the Pilot Plant and in the Control and Sales Product Laboratories becoming well-versed in all phases of the company's Industrial Division line of processing specialties. In addition to Nopco sales, Mr. Craig will be responsible for sales of the metallic soaps produced by the Metasap Chemical Company, a wholly owned subsidiary, serving the greasemaking, plastics, paint, varnish and lacquer, and other industrial fields.

HARRISON IS NOW WITCO'S VICE-PRESIDENT

At a recent meeting of the board of directors, Jerome S. Harrison was elected vice-president of Witco Chemical Company and designated manager of the Chicago office. Mr. Harrison has been connected with the sales office of Witco Chemical Company for the past 26 years and succeeds the late David Tumpeer in charge of the Chicago office.

Frederick C. Wissemann was elected financial vice-president and William Wishnick was designated to take over Mr. Wissemann's former position as treasurer, George J. Klipper was made assistant treasurer.

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The Institute Spokesman

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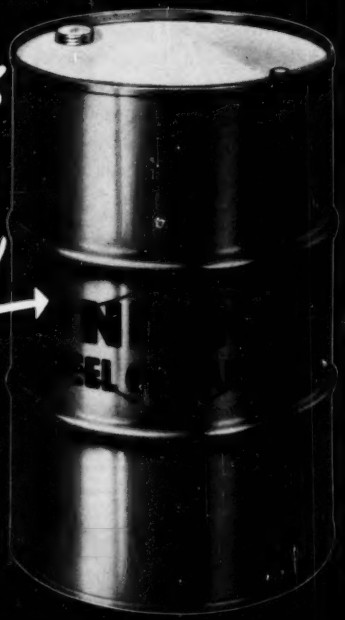
Sometimes the choice is obvious!



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The name INLAND assures your products absolute protection

Yes, the choice is easy when it comes to containers. Buy by name! Buy Inland Steel Containers and you buy the best — the most durable drums and pails made anywhere today.

Pails and drums in sizes from 3 to 55 gallons

There's no finer safeguard for your product than Inland Steel Containers — leakproof, sift-proof, airtight — they provide perfect protection in transit, in storage, and on the shelf, and they're available with colorful Inland lithography or printing, for added sales appeal.

It's better to ship in steel — and best to ship in Inland Steel Containers. Write for complete information.

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"LUBRICATE FOR SAFETY EVERY 1,000 MILES"

(*Continued from page* 23)

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To assist all companies and organizations interested in publicizing this essential message, CHEK-CHART will be pleased to furnish, without cost, proofs of the slogan in the generally used script style. These proofs will be sent on glossy stock, suitable for direct reproduction, in several sizes from 2" to 8" wide. Address your request to The Editor, THE CHEK-CHART CORPORATION, 31 East Congress Chicago 5, Illinois.

With full co-operation from the entire oil and automotive industries, the resulting billions of impacts of "Lubricate for Safety Every 1,000 Miles" will have a powerful and beneficial effect on car-owners to reduce our costly and tragic traffic accident toll.

NEW PLANT SUPERINTENDENT FOR THE WARREN REFINING AND CHEMICAL COMPANY

Frederick C. Schroeder has been named plant superintendent of The Warren Refining & Chemical Company, Cleveland, Ohio.

Mr. Schroeder graduated from Canisius College, Buffalo, New York, in 1943 with a Bachelor of Science Degree in Chemistry. Upon graduation he was employed by American Lubricants, Inc., Buffalo, New York, as a research and development chemist.

From 1945 to 1947, Mr. Schroeder was Assistant Research Chemist for the Carlisle Chemical Works, Reading, Ohio, where he developed 25 new types of esters, acid chlorides, coumarins, chlorinated derivatives, and sulfurized products. He then became Chief Chemist for Circo Products where his research and developmental work in new solvents and cleaning compounds attracted national trade attention. For the past 2 years he has been Chief Chemist for the J. W. Kelley Company of Cleveland, Ohio, where he developed lubricating oils and greases, drawing compounds and brake fluids.

He is a member of the American Chemical Society and the American Society of Lubrication Engineers.

LUBRICATE FOR SAFETY EVERY 1000 MILES

PURE

THE PURE OIL COMPANY'S LUBRICANTS PLANT SMITHS BLUFF REFINERY, Nederland, Texas

Home of Pure's complete line of superior oils and greases

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Your Industry NEWS

GROWTH OF MIDWEST RESEARCH INSTITUTE

The evolution of Midwest Research Institute as a prime contributor to the growth and development of the industrial and agricultural economy of the nation was highlighted by Dr. Charles N. Kimball, president, in his report to trustees at the annual meeting in Kansas City.

Kimball explained that operations during this, the Institute's most successful year, were a natural outgrowth of the sound and practical foundation upon which this institution is based.

During the fiscal year 1951, the Institute was involved in its greatest scope of research projects, with respect both to variety of technical fields covered and to the geographical location of sponsoring organizations.

In addition, he reported that 1951 was the Institute's most remunerative experience in terms of dollar volume of research. Over a ten-month period, research operations of this non-profit organization resulted in a total volume of nearly three-quarters of a million dollars, an increase of 44% over the same period last year.

According to Kimball, the Institute presents unique facilities not otherwise available in this part of the country. "A staff of 148 people, of whom over 100 follow active professional careers in twenty-five scientific fields, and with more than $500,000 in greatly diversified scientific tools available to them, provides the midwest with a clinic for the solution of its technical problems."

As further proof of the positive assets of an independent industrial research organization, Kimball cited figures to show that any industrial firm would require net sales of about $30,000,000 a year to justify a research department the size of the Institute, based upon the expenditure of 3% of gross sales for research. This would not include the initial expenditure of $500,000 in capital funds to equip its research laboratories nor the cost and effort involved in gathering a suitable scientific staff.

Part of the report was devoted to a discussion of important research programs during 1951. As of September 1, the Institute had undertaken a total of 638 research projects for 328 different sponsors, representing a total sponsored research volume since its beginning, of nearly 4 million dollars.

PRODUCTIVITY TEAMS VISIT CONTINENTAL CAN COMPANY

Members of two productivity teams from France and England, sponsored by the Economic Cooperation Administration, recently toured Continental Can Company's plant and research laboratory in Chicago, Ill., to determine whether any of Continental's methods are applicable to European use.

Twelve people were in the French group and 16 in the British, representing government, labor, management and technical personnel of the vegetable, fruit and fruit preserve industries and food associations of their respective countries. They were under the guidance of William R. Boynton and A. C. Fowler, both of the E. C. A.

The two teams were conducted through Continental's Clearing plant, and through their main research laboratory. The tour was followed by a two-hour discussion period during which C. H. Bloedorn, Continental's manager of overseas technical service, and S. L. Flugge, director of metal container research for Continental, answered questions relating to types of tin plate used in the United States; canning technology with particular reference to the use of the steam vac, and customer relations and canner costs.

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EVERY 1,000 MILES

AMERICAN LUBRICANTS, INC.
Buffalo, N. Y.

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Pure and Uniform

PENN-DRAKE PETROLATUMS

For the pure, dark grades of Petrolatums needed for maintaining uniformity and high quality in your greases, specify Penn-Drake. Made of 100% Pennsylvania crude, they will not "bleed" or "sweat" even under abnormal conditions. May we send samples?

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STEARIC ACID
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TUBULAR or SPONGE

GREENE Manufacturing Co.
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FUTURE MEETINGS of Your Industry

NOVEMBER, 1951

3-8 Oil Industry Information Committee, Stevens Hotel, Chicago, Ill.

5 New York Oil Heating Assn., Inc., Hotel Statler, New York, N. Y.

5-6 American Petroleum Institute (Committee on Agriculture), Stevens Hotel, Chicago, Ill.

5-8 American Petroleum Institute (31st annual meeting), Palmer House, Chicago, Ill.

5-8 A. P. I. Lubrication Committee, Chicago, Ill.

6-7 Nebraska Petroleum Marketers, Inc. (annual convention), Hotel Paxton, Omaha, Neb.

12-13 Petroleum Packaging Committee (bi-monthly meeting), Chrysler Building, New York, N. Y.

25-30 The American Society of Mechanical Engineers (annual meeting), Chalfonte-Haddon Hall, Atlantic City, N. J.

26 to Dec. 1 23rd Exposition of Chemical Industries, Grand Central Palace, New York, N. Y.

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The Institute Spokesman

The Official Publication of the National Lubricating Grease Institute

DECEMBER, 1951

2-5 American Inst. of Chemical Engineers (annual meeting), Chalfonte-Haddon Hall, Atlantic City, N. J.

3-4 Chemical Specialties Mfrs. Assn. (38th annual meeting), The Mayflower, Washington, D. C.

26-31 American Assn. for the Advancement of Science (annual meeting), The Bellevue-Stratford, Philadelphia, Pa.

★

JANUARY, 1952

14-18 Socy. of Automotive Engineers Inc. (annual meeting), Hotel Book-Cadillac, Detroit, Mich.

LUBRICATE FOR SAFETY

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ease lubrication problems
provide . . .

good solubility in lube oils . . .
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These three lead soap requirements are readily met by Witco's 30% and 33% Lead Naphthenates, 25% Lead Oleate, and 30% Lead Witall (Tallate). Witco Lead Soaps are extensively used in extreme pressure oils and greases. The clarity of these soaps is outstanding.

In addition to being non-corrosive themselves, Witco Lead Soaps are effective corrosion inhibitors.

For additional information or samples—write or call us today.

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#22, #23, #22-C, #22-G, #22-H
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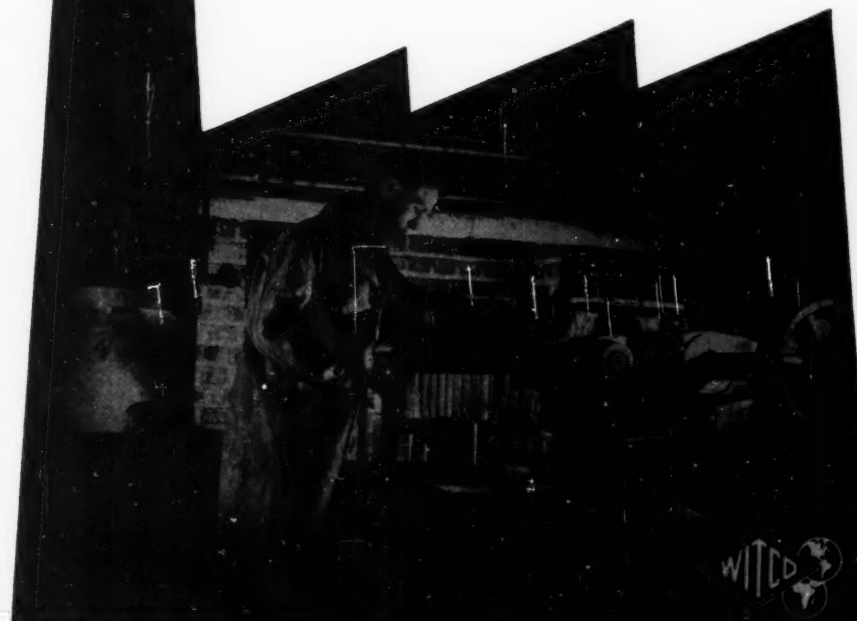

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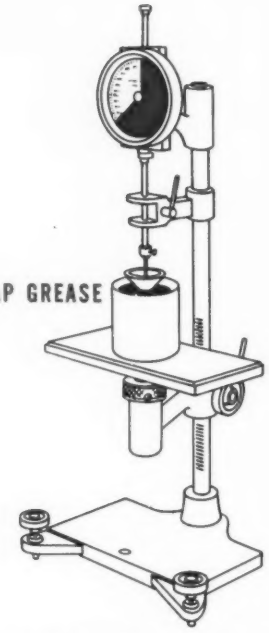

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Member—J. H. Baird

Mallinckrodt Chemical Works
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